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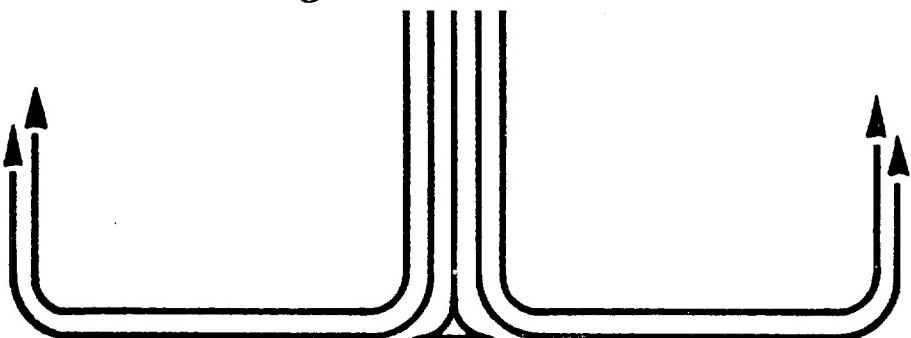
STUDENT REPORT

KC-135 LOW ALTITUDE TACTICS

MAJOR JAMES L. DAY

88-0680

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<p>Future conflict will be limited to the lower end of the conflict spectrum. Since aerial refueling will be required during low intensity conflict, there is a need to assess tactics for employment of the KC-135 during that conflict. The 305 ARFW, Grissom AFB conducted a low altitude training program from February to May, 1987. This study includes the results of that study. Low altitude air refueling and navigation are effective tactics which can allow a tanker to escort receivers closer to denied territory. This study recommends low altitude operation as well as additional supporting tactics to enhance low altitude flying.</p>			
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PREFACE

The purpose of this paper is to assess potential low altitude tactics for the KC-135 aircraft. Realizing that future conflicts will be limited to the lower end of the conflict spectrum, and aerial refueling will be required for aircraft involved in those conflicts, low altitude tactics have the capability to enhance mission success and KC-135 survivability. From March through May, 1987, the Tactics Division of the 305th Air Refueling Wing conducted six low altitude air refueling and navigation flights to assess KC-135 low altitude operation. This paper includes the results of that program, as well as potential employment options for the KC-135 in the low altitude environment. However, low altitude operation is not the only tactic needed. Additional tactics are included to be used with low altitude flying. They form a complete program of special mission tactics.



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ABOUT THE AUTHOR

Major James L. Day is a graduate of The Ohio State University and received his commission through OTS in 1975. He is dual rated (navigator and senior pilot) with over 3,200 total hours of flying time. Major Day was assigned to Grissom AFB, Indiana, on the completion of Undergraduate Navigator Training in 1976. During his three year tour at Grissom, he flew in the KC-135 A, D and R/T (refuelable tanker) and was an instructor navigator. He was a finalist in the 1976 SAC Bombing and Navigation Contest and was directly involved with initial experiments with navigation calculator use and training. In 1980 he completed Undergraduate Pilot Training at Vance AFB, OK. From 1980 through 1984, he served as an instructor pilot (T-37), class commander and chief, T-37 class commanders. In 1984, he was assigned to Grissom AFB as a tanker aircrew commander, and then a year later, instructor pilot, KC-135. As an instructor pilot and division chief at Grissom, he participated in Red Flag and missions in Central America (as pilot, instructor pilot, and operations officer). He was instrumental in the development of the 305th AREFW Tactics Division in 1987. The 305th ARKFW conducted six low level missions in the KC-135. Major Day flew as pilot in command/instructor pilot on five of these missions to demonstrate the feasibility of low altitude air refueling and navigation. Major Day has a Bachelor of Science Degree in Aerospace Studies from Ohio State and a Master of Arts in Public Administration from Ball State University. He is married to the former Deborah J. [REDACTED].

Topics in this report include:

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GLOSSARY

ACRONYMS

AFR	-	Air Force Regulation
AGL	-	Above Ground Level
AREFW	-	Air Refueling Wing
DoD	-	Department of Defense
EWO(s)	-	Electronic Warfare Officer(s)
GCI	-	Ground Controlled Intercept
JCS	-	Joint Chiefs of Staff
KCAS	-	Knots, Calibrated Airspeed- KIAS corrected for pitot/static installation and/or the attitude of the aircraft (15:A3-1).
KEAS	-	Knots, Equivalent Airspeed- KCAS corrected for compressibility-of-air error (15:A3-1).
KIAS	-	Knots, Indicated Airspeed- The uncorrected reading obtained from the airspeed indicator (15:A3-1).
KTAS	-	Knots, True Airspeed- KEAS corrected for density altitude (pressure and temperature) (15:A3-1). True Airspeed corrected for wind effects yields ground speed (GS).
NATO	-	North Atlantic Treaty Organization
SACR	-	SAC Regulation

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EXECUTIVE SUMMARY

Part of our College mission is distribution of the students' problem solving products to DOD sponsors and other interested agencies to enhance insight into contemporary, defense related issues. While the College has accepted this product as meeting academic requirements for graduation, the views and opinions expressed or implied are solely those of the author and should not be construed as carrying official sanction.

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REPORT NUMBER

88-0680

AUTHOR(S)

MAJOR JAMES L. DAY, USAF

TITLE

KC-135 LOW ALTITUDE TACTICS

I. Purpose: To evaluate the potential employment of the KC-135 during low intensity conventional and special operations, and to investigate how special mission tactics can enhance KC-135 survivability during these operations.

II. Problem: The KC-135 mission has changed from one dedicated to the strategic bomber force to multiple missions with varied receivers. KC-135 crews have primarily trained for a mission they have never flown, while periodically flying conventional missions within the realm of low intensity conflict (LIC) and special operations (SOPs). There is a need for special tactics to enhance the survivability of KC-135s involved in high visibility, politically sensitive missions.

III. Data: The concept of low altitude flying has been an effective means of allowing an aircraft to fly closer to a potential threat environment. Test programs by various SAC units have opened the door to the capabilities of KC-135 low altitude operation. The KC-135, in a high threat environment, will require additional tactics beyond just low altitude flying. The success of fluid maneuvering has been aptly demonstrated by C-141 crews and offers additional protection

CONTINUED

for KC-135 crews. Tanker electronic countermeasures offer protection for a task force as well as the tanker itself. Passive electronic protection is available and can be incorporated into the KC-135 airframe. Unit intelligence specialists have consistently been tasked to support wing Operations and Plans Division (DOX). This support sometimes becomes so nuclear warfare oriented, it excludes conventional support. There is a need for intelligence specialists to support special mission tactics and the regions which the tanker will be employed. Current support would have to operate on a part-time basis. Operation in the low altitude environment will require special criteria for the selection of aircrews and increase training requirements of the crews involved. Requirements for the boom operator would be greater than the other crew members.

IV. Conclusions: Low altitude operation offers enhanced survivability to crews and aircraft involved with low intensity conflict and special operations. Low altitude air refueling, navigation and fluid maneuvering add to the utility which aerial refueling offers. A total program of low altitude operation with emission control, ECM protection, and dedicated intelligence support can be an effective combination.

V. Recommendations: Continued consideration of low altitude operation should not be limited to just low altitude air refueling. There should be a total program, in conjunction with the air refueling, which would include compatible tactics. Competence in low altitude navigation is necessary to reach a low altitude refueling. HQ SAC should identify and qualify limited low altitude routes for KC-135 operation. The 1st CEVG should be tasked to investigate fluid formation, especially with low altitude operation. HQ SAC should investigate the possibility of incorporating passive ECM from decommissioned B-52s into a limited number of KC-135 airframes (to include reassignment of Electronic Warfare Officers). HQ SAC should evaluate the benefits of a single unit for these tactics, as opposed to a command wide program. USAF should attempt to incorporate low altitude air refueling into Red Flag type exercises as a proof of concept and a source of data for planners.

INTRODUCTION

In October of 1985, a combined strike force of Israeli F-16s and F-15s attacked the Tunisian headquarters of the Palestinian Liberation Organization (PLO). The strike was a reprisal for a PLO attack which resulted in the death of three civilians in Cyprus. An unqualified success, the final toll was 68 Palestinians and Tunisians killed, 100 wounded, and destruction of the PLO headquarters. The mission is significant because the strike force flew from Israel, 1500 miles across the Mediterranean, and then recovered in Israel after the attack. This was made possible by utilizing aerial refueling enroute to and from the target. The nature of peacetime contingency missions demands the capability to fly great distances over denied territory, undetected, attack and recover with the minimum of politically damaging losses (13:42).

From a system originally designed to support the strategic bomber force, the tanker has assumed multiple missions and varied receivers. The KC-135 has been employed in countless contingency missions and low intensity conflicts. In the meantime, the crews have consistently trained for a mission they have never flown (nuclear warfare) while periodically flying missions which were not the primary emphasis of their training. There are tactics available which can increase the survivability of the KC-135 and its crew during peacetime contingency missions (to include low intensity conflict and special operations).

Overview

Chapter One will detail the changing mission of the KC-135. Chapter Two will be an investigation of how the tanker may be employed in future low intensity conflicts. No attempt will be made to evaluate the Strategic Air Command's (SAC) capability to support the nuclear mission. This report makes the assumption SAC is fully capable and trained to support any level of nuclear combat. Chapter Three will discuss three new low level tactics for the tanker. This information is from a low altitude training program conducted by the 305th Air

Refueling Wing Tactics Division. In support of a total program, Chapter Four will recommend additional tactics and procedures to enhance tanker survivability. Chapter Five will discuss considerations for aircrew selection and training for special mission tactics.

CHAPTER ONE

THE KC-135 EVOLUTION

Early Mission

The KC-135 originally had a primary mission devoted to the nuclear forces of SAC and a limited secondary mission for the Tactical Air Command (TAC). As an integral part of the land/sub ballistic missile, bomber triad, KC-135s serve to extend the range and capabilities of the manned bomber force by supplying large offloads at jet speed (12:220). Also, as the KC-135 began operational service, SAC was designated as the Air Force single air refueling manager (1:12). SAC would be responsible for all refueling assets and requirements. This would require the KC-135 to assume support for the strategic bomber fleet, as well as the entire USAF.

The needs of receiver commands were not difficult to satisfy during the early days of this dual role for the tanker fleet. Only a small portion of the tactical fleet (approximately one-fifth) was air refueling capable. None of the aircraft in the airlift fleet were air refuelable. (9:77). The full capability of aerial refueling was not readily known nor tasked within either SAC or TAC. USAF aircraft could operate easily worldwide because America emerged from World War II in a position of strength. Basing rights were easily gained or maintained to assist in deployment and employment. American military aircraft could operate on a world-wide basis with few restrictions on landing rights. SAC's assigned refueling mission, as well as the world situation, have changed considerably.

A Changing Commitment

During the 1960s, the mission of the KC-135 included an ever increasing role in conventional air refueling commitments. The Vietnam War proved to be the beginning of an increased demand for non-SAC air refueling. The first KC-135s were sent to Southeast Asia in January, 1965, even before

the first B-52 (1:65). Tankers were eventually used for fighter and bomber assets throughout the conflict in a contingency mission which "grew to dominate the command (1:225)." Tankers flew as part of the Young Tiger Tanker Task Force. Operating in an environment of virtual air superiority, their air refuelings were rarely threatened by enemy airpower.

The experience gained in Vietnam had an impact on future fighter air refueling capabilities. Some early fighters utilized the probe and drogue system, but when a drogue is connected to a KC-135, receptacle type air refueling cannot be conducted. All new aircraft would be air refueling capable and have common air refueling systems. Fighter commitments were not the only change in demands placed on air refueling.

The airlift fleet has increased its demands for air refueling. The necessity for air refueling became apparent during the 1973 Arab-Israeli conflict. Initially, European countries refused landing rights to aircraft resupplying Israel. Portugal eventually allowed operation from Lajes in the Azores. This situation resulted in a reappraisal of tanker capacity (KC-10 for C-5 air refueling) and the addition of an air refueling system to C-141s (9:77).

The USAF maintains an obligation toward DOD wide air refueling support. According to AFR 23-12, SAC:

. . . carries out its responsibilities for strategic offensive combat according to directives and policies issued by the JCS and HQ USAF and performs other functions assigned by competent authority. These duties include offensive nuclear and non nuclear strikes, reconnaissance, air refueling asset management . . .
[author's underlining] (14:1)

The responsibility for all air refueling needed by both the USAF and the JCS is under SAC. KC-135 crews now maintain information to refuel Navy, Marine, as well as certain NATO aircraft (27:--). This is a source of additional air refueling demands. Of greater significance is the change in tanker support for the bomber fleet.

The changing bomber mission has affected tanker conventional commitments since the Vietnam conflict. B-52s became heavily involved with the conventional conflict of Vietnam almost to the exclusion of their nuclear commitment (1:225). In 1980, bombers were assigned to the Strategic Projection Force (8:49) and anti-shipping missions have also been added (8:24). Of 159 B-52Gs earmarked for retirement from SAC, 61 will be shifted to conventional missions as the Advanced Technology Bomber (ATB - Stealth) becomes operational (10:24). In his book, Stealth Aircraft. Secrets of Future Airpower, Bill Sweetman suggests the possibility of a decreased demand for air refueling by the ATB, thereby releasing more tanker aircraft for conventional missions (8:80). Along with the increased demands placed on our air refueling assets, the nature of conflict has also changed.

Low Intensity Conflict and Special Operations

Since the KC-135 entered the USAF fleet, the likelihood of global nuclear or conventional warfare has decreased. The capabilities of the Soviet Union have changed considerably from both a conventional and a nuclear standpoint. As the Soviets attained nuclear parity, potential conflict has changed from a global or theater level to localized, more limited conflicts. Small wars, as a result of revolutionary movements and Soviet block instigated instability, have become more likely. More emphasis has and will be placed on conventional forces (8:48). Limited conflicts require the use of small forces (as opposed to the large Young Tiger type conventional operations). The need exists for specialization to support low intensity conflict (LIC) and special operations missions.

Summary

Originally intended for a mission it has never flown (air refueling support for the Single Integrated Operation Plan, SIOP), the KC-135 has been employed in countless conventional missions (Urgent Fury, El Dorado Canyon, Desert One, for example). It has accepted additional receivers and missions not anticipated when it was designed (9:77). To support these missions, SAC has assumed the dual role of full-time nuclear air refueling support and part-time conventional support. Chapter Two will evaluate potential future conflict, how the KC-135 will be employed within that conflict, and SAC's capability to support it.

CHAPTER TWO

KC-135 IN LOW INTENSITY CONFLICT

Location of Conflict

In The Air Force Role in Low Intensity Conflict, Lt Col David Dean made two important points about the future of conflict and confrontation between the United States and the Soviet Union. Since they gained equivalence, and assuming deterrence works, conflicts will not be at the nuclear or large conventional level (since it may lead to escalation to nuclear confrontation). Smaller, more limited wars will be more likely and confrontation between the United States and the Soviet Union will most likely occur in the third world lesser developed countries (2:11-12).

Investigation of conflict since World War II indicates most conflict has taken place within 100 miles of what political geographers classify as the baseline regions of the world. The baseline region is defined as "... a line drawn along the outer fringe of the land from which seaward distances are measured, are considered national territory and are subject to state control on the same terms as land (7:116)." Operations against these regions may prohibit internal basing rights and they may not be available enroute. The KC-135 will continue to be committed throughout the spectrum of conflict, but it will most likely be employed in low intensity conflict (LIC) and special operations (SOPs) against the baseline regions of the world. Location of third world countries and their acceptance of foreign basing may require aerial refueling for aircraft flying LIC and special operations missions. For future LIC, SAC may have to evaluate the KC-135s ability to support the increased complexity of LIC missions.

Mission Factors

If one makes the assumption air refueling will be needed during limited and special operations, it would be helpful to review how operational factors for various levels of conflict

change. Significant mission factors are:

1. Political sensitivity
2. Operational security
3. Emission control
4. Navigation
5. Formation
6. Air refueling
7. Electronic countermeasure (ECM) protection
8. Tactical deception

An evaluation of these factors reveals an emerging similarity between nuclear and large conventional (Young Tiger or European Theater) missions. On initiation of the SIOP or during conventional warfare, the concern for political sensitivity is reduced (due to the level of warfare). Operational security is also of limited necessity. Emission control becomes more critical as the refueling area is approached. Enroute navigation, formation, and air refueling would be conducted at high altitude to take advantage of low fuel consumption rates (due to the long distances flown enroute to the air refueling). Since the KC-135 does not possess electronic counter measure (ECM) equipment, it will need to rely on the receiver (buddy) or dedicated ECM aircraft (EF-111, EC-130). Tactical deception will be limited for the SIOP mission but of value for a conventional mission. The situation changes for LIC and SOPs.

LIC and SOPs also share a similarity in mission factors. Operation in and around other countries during peacetime requires empathy for their political situation, airspace, and relations with neighboring countries. Political sensitivity (as well as the mission) demands attention to operational security. Any available tactic employed enroute would be used, to include low altitude navigation and air refueling. Formation should consider the greater risk and enhance mutual protection and support. ECM protection would be the same as the SIOP/conventional mission, but consideration should be given to buddy or internal ECM protection. Tactical deception should be used in all aspects of the mission. LIC and SOPs missions have an inherent degree of complication due to the

nature of their mission. Moving through the spectrum of conflict from nuclear to special operations, the complexity and variety of the mission tactics increases. Due to the demands of the SIOP, mission factors must be kept simple. There is an advantage in the similarity between training for the SIOP and conventional missions.

Training for the SIOP

A review of SACM 51-135 (KC-135 training) illustrates the omnipresence of SAC's SIOP mission. Ground training requirements for EWO (Emergency War Order or nuclear warfare) study, alert starts, and command and control procedures (19:atch 7) as well as flying training requirements for crew directed training sorties, minimum interval takeoffs, and special air refuelings (19:atch 10) indicate the predominance of the command's primary mission. SACR 51-135 lists approximately seven recurring ground training and 11 flying training events which are EWO related. Except for those items which have some commonality, there are five items listed for conventional operations. Training for limited and special mission tactics are conducted outside the constraints of SACR 51-135.

Unless an operational unit has a special refueling mission, crews do not practice special mission tactics. Aircrues deployed in support of special missions are usually briefed on arrival. Crews receive a SAC Contingency Air Crew Training (SCAT) briefing as part of their orientation to the particular area or country from which they will be operating. They fly initial missions with instructors or more experienced crews (21:3-9). Crews often deploy with limited intelligence information on the area from which they will be operating.

Intelligence Support

The demands of the EWO mission hamper wing intelligence branches from fully supporting limited conventional operations. According to SACR 200-14, Intelligence Functions and Responsibilities, the wing intelligence branch (DOXI) is assigned to the wing operations plans division (DOX). They:

. . . support unit missions . . . provide weekly briefings . . . and prepare, present, and update intelligence inputs to unit mission briefings, initial sorties study, alert force briefings, and EWO study (23:6-1 - 6-2).

Although tasked to "support unit missions," the demands of their EWO tasking prevent them from effectively supporting LIC missions. The author has found their efforts tend to be directed toward the EWO mission, to include clerical support for DOX. Initiatives in support of the SAC Tactics Program have added to their duties by requiring support for the Tactics Division and increased threat awareness training (22:3-3). The Tactical Air Command specifies a need for intelligence specialist mobility to forward areas with emphasis on experts in operations, target, and ECM intelligence (25:--).

Summary

The LIC and SOPs end of the mission spectrum requires tactics and procedures which SAC tanker units may find impractical to maintain proficiency on a regular basis. Many of the skills required to operate in areas requiring special tactics, operational security, extreme emission control, and tactical deception cannot be learned during SCAT briefings or short familiarization flights. These skills must be practiced on a regular basis and ingrained into flying discipline and habit patterns. Also, the capability for special tactics exists, and once integrated within a specific organization, will expand the capabilities of tactical planners. Three of these special tactics are the subject of Chapter Three.

CHAPTER THREE

LOW ALTITUDE OPERATIONS

The three most promising tactics for LIC are low altitude navigation (LAN), low altitude air refueling (LAAR), and fluid formation. Although there has been some investigation of KC-135 low altitude tactics, employment should entail supporting tactics to enhance KC-135 survivability during LIC. The information on LAAR/LAN in this chapter is from a low altitude training program conducted from February to May, 1987, by the Tactics Division of the 305th ARFW at Grissom Air Force Base (See Appendix A). The author participated in five of the six missions. This program attempted to investigate the KC-135s ability to exploit the limits of radar at low altitude.

Radar Horizon

The advantages of low altitude flying have been known since the invention of radar and the realization radar is limited by line of sight and terrain irregularities. Aircraft remaining outside the horizon-induced limit of radar could remain undetected. Radar horizon distances can be computed using the formula:

$$\text{Radar Horizon Distance} = 1.23 * ((\sqrt{RA}) + (\sqrt{AA}))$$

(18:6)

Where:
RA = the radar's antenna altitude
AA = aircraft altitude

Using this formula, a table of predicted radar horizon distances for given antenna heights can be developed (see Table 1). For example, an aircraft operating at 3000 feet against an antenna 20 feet high will remain undetected until it is within 73 miles of the antenna.

Predicted Radar Horizon Distances (nm)

Antenna Heights (ft)

Altitudes (ft)	10	15	20	25	30
	1	11	1	11	1
10,000	127	128	129	129	130
9,000	121	121	122	123	123
8,000	114	115	116	116	117
7,000	107	108	108	109	110
6,000	99	100	101	101	102
5,000	91	92	92	93	94
4,000	82	83	83	84	85
3,000	->- - -	-71- ->-	72- - ->	73	74
2,000	59	60	61	61	62
1,000	43	44	44	45	46
500	31	32	33	34	34
400	28	29	30	31	31
300	25	26	27	27	28

Table 1

Tanker Low Level

Task forces approaching baseline regions can take advantage of the radar horizon during overwater approaches to targets. They would fly an enroute descent, remaining below the radar horizon for a given range. Also, low flying aircraft are able to effectively exploit terrain masking. This further complicates radar detection (18:6). Intelligence appraisals of local antenna locations and heights as well as terrain irregularities would determine the appropriate altitudes. The detection free altitude (FG) is computed by:

$$FG = AB + (AG * CD/AE)$$

Where:

- AB - Antenna altitude
- AE - Distance of an obstacle from the antenna
- AG - Aircraft distance from antenna
- CE - Obstruction altitude
- CD - Obstacle height above antenna height (18:6)

Progressively lower altitudes imply an increasing acceptance of exposure to greater risk. There is a limit to the threat which a tanker should be subjected and the altitude which it should be flown.

When the subject of low altitude flying is suggested, it often alludes to flying below 500 feet, during low level bomber or fighter penetrations in rugged terrain. A KC-135 would not need to operate at such extreme low altitudes. The intent of KC-135 low altitude operation would be to allow a tanker to follow receivers closer to the target area. Operation to as low as 1000 feet AGL would allow operation within 50 miles of an enemy transmitter. Operation at 3,000 ft would be sufficient for most missions (allowing an approach to within 75 nm of antennas of 30 ft in height). Tankers do not need to operate continuously at their minimum altitude.

Factors such as crew comfort/experience, terrain, shadows, and vegetation can affect the selected altitude (11:10). Ultimately, the ability of the aircraft structure to withstand operation at low altitudes/high speeds and the radar horizon determine the required minimum altitude. Two tactics which can be used to exploit low altitude flying are low altitude air refueling and navigation.

Low Altitude Air Refueling (LAAR)

As Chief of the Tactics Division at Grissom AFB, the author participated in four low altitude refueling missions and one low altitude navigation leg from March through May, 1987. The purpose of these missions was to test the capability of the KC-135 to operate in the low altitude environment. Aircraft control and response was excellent and in no way presented a danger. Data recorded during two flights (see Table 2) indicate the range of angle of attack and airspeeds encountered during low and high speed refuelings. For some receivers (those with air refueling speeds below 250 KIAS) air refueling speeds had to be increased. This was required by receiver aircraft controlability and a reduction in the refueling boom envelope. Refueling speeds above 250KIAS can be flown as published and the addition of 10 KIAS should be considered in light turbulence (28:3).

Throttle response was sensitive (as in the traffic pattern) and less experienced crews tended to chase airspeeds. With time and experience, they overcame this tendency. Increased throttle response did have some benefit. It enhanced emergency separation of aircraft. Although hampered in altitude separation (due to the proximity of the ground), aircraft separation was quicker. Nose-to-tail separation is the essence of an emergency separation, so the increase in throttle response permitted a quicker separation during emergencies. Power response caused a pronounced "pitch up" during separation which may be disconcerting to receiver pilots. This can be overcome by the use of normal rated thrust (NRT) during breakaways rather than military rated thrust (MRT) (28:1-2).

Air Refueling Data

5000 feet PA*
(4000 feet AGL)

IAS AOA MACH DAT**

220	.40	.36	+4
230	.35	.38	"
240	.31	.39	
250	.30	.41	
260	.28	.43	

6000 feet PA
(5000 feet AGL)

IAS AOA MACH DAT**

273	.30	.465	+16
275	.31	.47	"
285	.36	.48	+17
300	.34	.52	+19
310	.25	.529	"
315	.22	.53	
320	.21	.535	
330	.18	.55	
335	.17	.565	

* pressure altitude (PA)

** uncorrected outside air temperature

Source: Flight test data. Local elevation app 1000 feet.

Table 2

Boom controllability was good. A reduction in drag during retraction resulted in a pronounced tendency for the boom to drop or disconnect at all speeds. Turbulence had the greatest affect on boom controlability. A recommendation from the Combat Evaluation Group (CEVG) to avoid turbulence greater than light is valid. During one mission, daytime surface heating resulted in turbulence greater than light and the refueling was stopped. The instructor boom operator said contacts, up to that point, were difficult and impossible during occasional moderate turbulence (30:--).

Fuel flows for the tanker averaged approximately 4000 Lbs per hour per engine (16,000 lbs per hour total). This is twice normal cruise fuel flows and could hamper employment offload capability. Higher fuel flows could be significant for a receiver with limited fuel capacity and require more frequent cycles through the boom (30:3). To reach the low altitude refueling area, a limited amount of low altitude navigation will have to be mastered and flown.

Low Altitude Navigation (LAN)

The program included a low level route flown at 2000 feet AGL and 330 kts ground speed. The aircraft operated well at this low altitude and high speed. However, acceleration margins (to gain time) are extremely limited at 300 kts. Along the low altitude route, winds at altitude occasionally exceeded 25 knots. The differential between 300 Kts and the KC-135 limiting airspeed of 350 KIAS (at this altitude indicated airspeed and true airspeed are practically equal) left only a small amount of airspeed to correct for lost time. A ground speed of 280 kts may be more helpful for time control (29:--).

The rudder and elevator axes (including altitude hold) of the autopilot were engaged. This allowed the pilot to concentrate on heading control rather than altitude control. Light turbulence was evident throughout the route. This configuration seemed to place unnecessary strain on the autopilot. A better combination of autopilot operation would be to use all axes except elevator/altitude hold (use heading

select for heading control). The radar altimeter can be set for terrain clearance with the pilot concentrating on altitude control. Operation at low altitudes and closer to potential threats demands the mutual protection of formation flying.

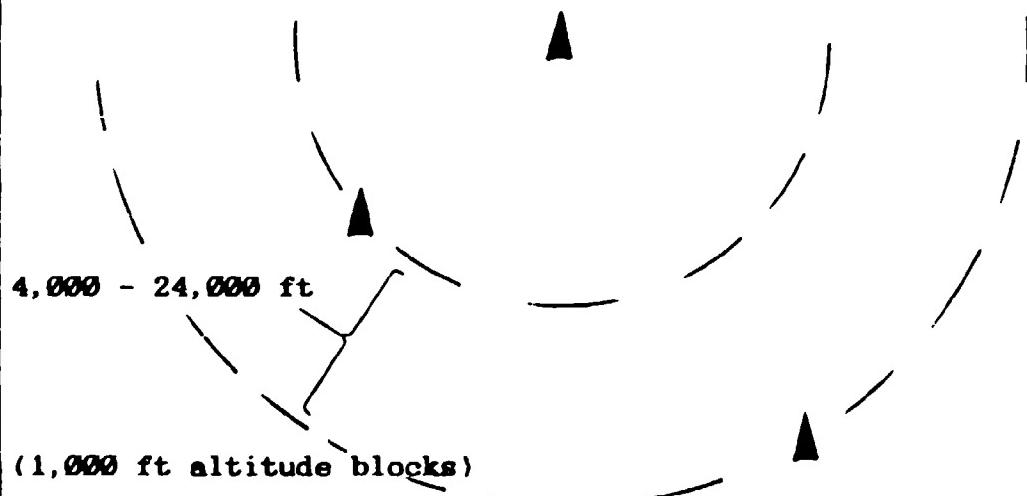
Tanker Formation

In a high threat environment, current tanker cell formation fails to assure the original intent of formation, mutual protection and support (16:38). SAC currently utilizes an enroute type tanker cell where tanker aircraft are in 1000 feet blocks, stacked up, with one nautical mile nose-to-tail separation between tankers (20:7-2). This is an effective way to move large formations of tankers enroute to a SIOP air refueling or in an area where virtual air superiority is assured. In the tanker cell, mates are unable to clear the four through eight o'clock positions. Operation in higher risk environments demands additional protection of cell mates. A more practical tactic would be utilization of fluid trail (see Figure 1). Aircraft operate around lead as required to stay within their arc. A one thousand foot block can be used for altitude separation. The lower half of Figure 1 shows fluid trail support responsibilities for clearing. The letters represent (P)primary, (S)econdary, and (T)ertiary areas of responsibility. Fluid trail is currently employed by the Military Airlift Command (MAC) for C-141 cell operation (17:30). This ". . . assures maximum flexibility, maintains formation integrity, allows more freedom for evasive maneuvers [and allows observation of a wingman's four through eight o'clock position] . . . (17:22-26)" Wingmen maneuver as required during turns to maintain position and aid in visibility. Fluid trail would be flown enroute and then switched to air refueling cell or maintaining a modified fluid trail. Operation at low altitude, while beneficial in most respects, has some limitations.

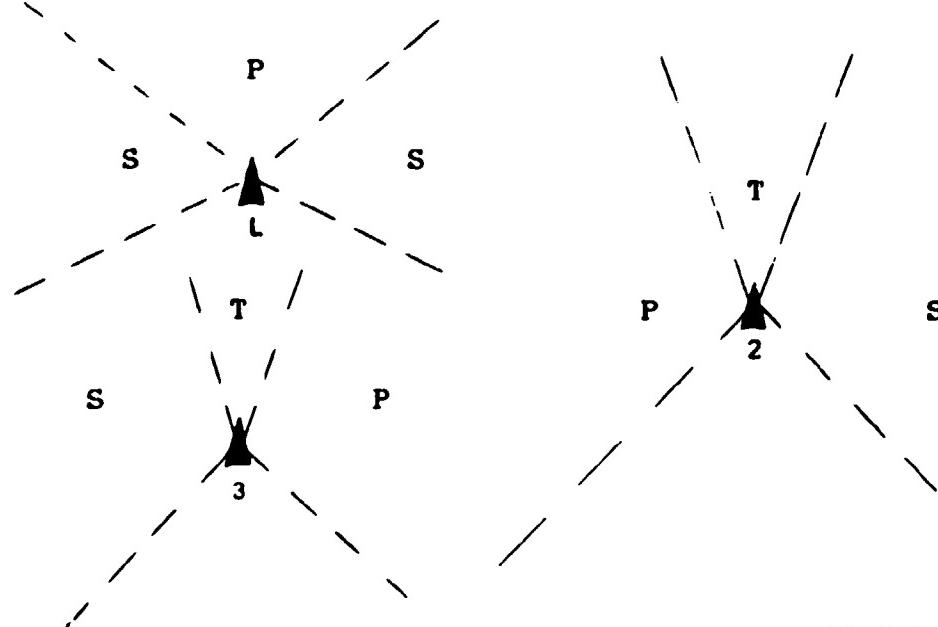
Structural Limitations

Disadvantages include the increase in structural fatigue, crew discomfort with low altitude flying, and the detection capabilities of doppler type radars (look-down, shoot-down). In 1985, an Air Command and Staff research paper detailing operation of the KC-135 within the low altitude regime warned of the potential increase in crack growth rates at

FLUID MANEUVERING



FLUID TRAIL MUTUAL SUPPORT RESPONSIBILITIES



(17:30-31)

Figure 1

low altitudes. These rates increased considerably below 3,000 feet and above 250 KEAS (Knots Equivalent Airspeed, approximately three knots different from KIAS in the KC-135). At or above 3,000 feet the rates were slightly higher than air refueling conducted at 25,000 feet. For a given altitude, structural crack growth factor will also increase with airspeed. A change in airspeed from 250 to 300 KEAS results in a doubling of structural crack growth factor (26:12). Although an increase in crack growth rate is significant, it can be minimized by limiting the time at low altitude. As was previously discussed, flight profiles would resemble an "enroute descent" and refueling would be conducted without delay. The intent of low altitude air refueling is not to simulate fighter/bomber penetrations. Although the aircraft performed well in the low altitude environment, crew anxiety and discomfort readily became apparent.

Crew Anxiety

Crew members expressed a wariness with the low altitude environment which could not be attributed to experience or ability. They were concerned about such factors as ground proximity, bird strikes, low altitude civilian traffic (even though all flights were confined to a restricted area), and aircraft structural integrity. This anxiety was apparent in crew members actively involved in the program as well as other crew members who faced the possibility of participating in low altitude air refueling/navigation. The accident at Fairchild involving the KC-135/B-52 demonstration team (operating well below planned LAAR/LAN altitudes) increased this anxiety (29:2). Changes in radar technology have also affected the viability of low altitude operation.

Airborne Radar

Countries possessing airborne look-down, shoot-down radars have a definite advantage in detecting low altitude attacks (3:19). One of the factors in the radar horizon formula is antenna height. The same aircraft operating at 3000 feet against an antenna height of 25,000 feet (in an Airborne Warning and Control, AWACs, type system) would have a radar detection horizon of 261 miles. These radars are usually pulsed doppler radars and capable of detecting moving targets in ground clutter. (24:28).

Although operation against doppler type radars is a serious consideration, this paper began with the assumption low intensity conflict would be conducted against countries possessing less sophisticated systems. Operation of Soviet Mainstay or Moss (Soviet AWACS) type systems would put an entire task force in jeopardy without adequate ECM protection. However, this paper will suggest a possible ECM protection plan.

Summary

Low air refueling, navigation, and formation are viable tactics to enhance KC-135 survival. Operation below enemy radars will allow tankers to accompany receivers closer to target areas without additional risk. The features of low altitude flying should not detract from the need to investigate additional tactics. Tankers operating in the high threat, politically sensitive environment of LIC and special operations need additional tools to be effective. This will be the subject of Chapter Four.

CHAPTER FOUR

SUPPORTING TACTICS

ECM Protection

As Chief of the 305 AREFW Tactics Division, the author found that crew members often expressed concern with the lack of electronic counter measures (ECM) for the KC-135. The KC-135 has no capability to detect or counter unfriendly use of the electronic spectrum. Also, when deployed at forward locations, the KC-135 is extremely vulnerable to low altitude, man portable surface-to-air missile systems. Four engines operating at 600-700 degrees centigrade (327-427 degrees Kelvin) produce an excellent infrared signature. This is well within the eight to 13 micron "window" of hot plume or hot metal seeking surface-to-air missile infrared seeker heads (3:16-17)(4:42). Combined with low speed and lack of maneuverability during take-off, it is vulnerable to SA-7 and SA-14 type systems.

Currently, the only protection for the KC-135 is the ECM capabilities of other aircraft (buddy ECM). Aircraft such as the EF-111, EA-6B, and B-52 can supply useful information to a tanker task force (5:60). These assets may not be available or practical to use in very limited strike operations. Their use may divulge intent or bring unwanted attention to the operation.

ECM pods (either procured or surplus from the tactical forces) as well as chaff and flare dispensers, have been suggested as modifications. Limitations of passive ECM equipment and the cost of acquisition have prevented these modifications. As a solution to both problems, the previously mentioned retirement of 98 B-52s provides a source for passive ECM equipment. Retrofit of this equipment into a limited number of KC-135s and reassignment of a sufficient number of electronic warfare officers would provide a formidable electronic detection platform. This retrofit could be done with minimal cost (in relation to acquisition) and provide the human link necessary to effectively interpret and

counter electronic detection and interference. In the mean time, the smart use of emissions needs to be emphasized during training.

Emission Control

Emission control is not the absence of emissions, it is the selective and smart use of emissions. Currently, SAC recognizes four emission control (EMCON) options. According to SACR 51-135 they are:

EMCON One - Any and all emitters are authorized to insure timely training/feedback and maximum safety. EMCON one is used for initial qualification, requalification, category qualification and difference training for tankers and receivers.

EMCON Two - Restricted [communications], radio silent formation except for rendezvous and air refueling conducted with only two radio exchanges. . . . the standard for daily training.

EMCON Three - [Communications] out, radio silent formation, including rendezvous and refueling. The use of other emitters is authorized unless prohibited by supported operations plans etc. . . . for exercises and operational missions only . . . utilize this option after thorough coordination with the receiver unit.

EMCON Four - Emission out no [sic] emitters will be used unless specifically authorized by the plan supported. This includes radios, doppler, radio navigation transmitters [VOR, TACAN], radar, radio altimeters, IFF, exterior lights, etc. This option will not be practiced during peacetime operations unless specifically tasked by [Numbered Air Force] or [Higher Headquarters] due to [Federal Aviation Administration] identification requirement.

EMCON definitions taken from SACR 51-135, A2-29, and edited by James L. Day/Maj.

Emission sources may be turned on or off (regardless of the emission option), as required, to falsely "telegraph"

intent. More directional use of radar sweeps and compressed antenna scans can effectively prevent detection. A LIC/SOPs tanker unit would need to practice these selective emission to include EMCON four. Its use in special operations is critical. Considering the difficulties involved with this procedure, it should not be learned during employment. The use of night vision goggles for formation operation and enroute flying would assist in EMCON four operations. To tie these tactics together, simulated strikes should be practiced on a recurring basis.

Exercise Participation

The successful application of LIC/SOPs tanker tactics can be practiced during Red Flag type exercises. Planners would then have the opportunity to integrate low altitude navigation and air refueling into strike scenarios. Tactical forces would be required to protect air refueling assets. Proper application of ECM aircraft and EMCON practices could also be effectively integrated into the exercise. Inter-service operation could be a part of these exercises and perhaps expanded to support the Carrier Battle Group. Refueling technical orders have carried Navy and Marine refueling data for years. Fleet operations involve procedures and terminology which cannot be practiced on a regular basis by all SAC tanker units. Operations with Naval units are a must to exploit the capabilities of Carrier Battle Group support.

Dedicated Intelligence Support

A specific intelligence group for low intensity operations, not under the demands of operations and plans (DOX), would be required. Area specific experts could maintain current intelligence on political, military and economic factors for a given region (ie., the Middle East, Latin America). This group would have the capability of deploying with the unit to forward locations to assess threats and debrief returning crews.

Summary

Effective employment of low altitude operations will depend on supporting tactics. Proper skills in EMCON and use

of ECM will enhance the capabilities of LAAR and LAN. The support of dedicated intelligence specialists will supply crews with vital information on the geopolitical situation as well as threat awareness. Participation in tactical exercises will allow evaluation of present skills and an awareness of future requirements. Initial cadres of crews can be formed in one of two ways. "Select" crews from tanker wings SAC-wide can use these tactics on a part-time basis while maintaining other air refueling skills and tactics. The other alternative would be to assign a specific unit to this mission. Chapter Five will discuss training and selection considerations involved in implementing either plan.

CHAPTER FIVE

CREW SELECTION AND TRAINING

The capabilities of low altitude operation, while offering increased capabilities for tanker employment, should not be used without the additional tactics mentioned in Chapter Four. These tactics add to the survivability of the aircraft. Proper selection and training of crew members is also an important part of special mission tactics. Properly identifying the right person for the job and then maintaining these skills are the keys to successful employment.

Crew Selection

The purpose of the last phase of the low altitude training program at Grissom was to begin training crew members in the skills necessary to conduct low altitude air refueling and navigation. As other than training-flight crew members became involved, it became obvious the usual criteria for selection were not valid. In most cases, crew members are selected for advanced training primarily by flying hours. Although other factors are important, this is true in selecting candidates for upgrade to aircrew commander and instructor positions. The program clearly showed the need for subjective rather than objective criteria for entry into training. Comfort with the low altitude environment was the dominant factor.

The crew discomfort associated with low altitude flying hazards such as civilian aircraft, birds, and ground proximity became apparent as the program progressed. Actions taken to insure safety made little difference. Flights were conducted at no lower than 2000 feet AGL in restricted area R-5503 (in the southwestern corner of Ohio). R-5503 is owned by Wright-Patterson AFB and includes the airspace from just under 2000 feet AGL to flight level 600. The area is well known by local civilian pilots and monitored by both Indianapolis Radar and Wright-Patterson Flight Test GCI. Although low altitude hazards were minimized, the need for an alternative selection

process became apparent.

Informal discussions with CEVG and training-flight instructors resulted in criteria for selection into the low altitude program. Factors in order are:

1. A volunteer
2. Comfort with the low altitude environment
3. Aggressiveness
4. Airmanship
5. Current duty position (preference for IBOs in the boom position)
6. Flying hours
7. C-130 experience
8. Unshakability

(30:2)

Flying hours is relegated to sixth position. The first five factors proved to be more limiting in the crew member's ability to do his/her job. The preference for an instructor boom operator is indicative of how required skill levels vary with crew position.

Crew Position

Each crew position had different demands placed on its skill. The most critical position was the boom operator. Limits of boom controllability and problems with turbulence were beyond the capability of one instructor boom operator. Two flights in relatively calm air produced a deceptive level of confidence which was shattered on the first contact with light turbulence. A boom less controllable than normal, bouncing in light turbulence, can be very unnerving to even an experienced boom operator's patience. Pilots could generally learn low level refueling skills within two missions. Emphasis was primarily on power control and visual flying. Pilots flying in the air refuelable tanker felt refueling was easier because the aircraft was more responsive. Unfortunately, only one mission as a receiver was attempted (31:--). Navigators graduate from Undergraduate Navigator Training with the required skills for limited low level

operation. The APN-59, search radar has a reduced "picture" but is no worse to interpret than during traffic pattern operation. The varying demands placed on crew skills are reflected in continuation training requirements.

Continuation Training

The boom operator position would require more periodic training to maintain proficiency. The difficulty associated with making successful contacts in light turbulence will require boom operators to practice their skills more often. The recommendation from training flight IBOs and CEVG was one low altitude contact every 45 days. Pilots and navigators could maintain excellent proficiency for refueling and navigation on this same schedule. They would be assured of accomplishing the event every 45 days because these would need to be integral crews with very limited substitutions. Multiple boom operators on a sortie may not be a satisfactory practice. The desire would be to limit aircraft structural fatigue so flights would involve one boom operator and limited low altitude air refueling time. The periodic requirement for training in low altitude fluid maneuvering and receiver air refueling by KC-135 R/Ts would need to be determined through inflight testing by CEVG.

Summary

The demands of operation in the low altitude environment place new criteria on the selection of crew members and increased demands on their training. Taken alone LAAR, LAN, and fluid maneuvering can be effective in enhancing the survivability of the KC-135, but they should be part of a total program for operation within the LIC end of the mission spectrum.

RECOMMENDATIONS

1. Continue with the low altitude training program (LAAR/LAN) as a source for LIC refueling. Develop tactics which stress an enroute descent type of LAAR. Unless tasked by a specific air tasking order, LAAR should not be conducted lower than 3,000 feet AGL and LAN should not be more than 300 KIAS. The

airspeed would be increased to conduct air refueling.

2. Investigate fluid maneuvering as a specific mission tactic for low level operation. Operation with receivers should also be attempted.

3. Conduct additional study in selection and training of potential crew members.

4. Analysis should be conducted on the possibility of utilizing ECM suites from decommissioned B-52Gs in KC-135 "pacer aircraft" for ECM protection. This would include the reassignment of EWOs to special mission tactics units. They would serve in the additional capacity of low altitude observer.

5. Additional study needs to be conducted on the efficacy of a single unit (or two, one for 15th Air Force and one for 8th Air Force) as opposed to all tanker squadrons qualified in low altitude tactics. The study should address maintenance tracking of airframes, scheduling of aircraft to be used for LAAR/LAN, management of "corporate knowledge" and crosstalk, and command structure for employment.

6. Investigate the costs (especially considering recommendation number five) of assigning intelligence specialists to this mission.

7. Incorporate LAAR/LAN into Red Flag scenarios to include required combat air patrol protection of tanker assets.

CONCLUSION

The KC-135 will continue to be an effective extension for force projection. Since future conflict may involve small wars in difficult to reach regions, there is a need for air refueling by crews skilled in tactics commensurate with the

LIC, SOPs environment. LAAR and LAN are the answer to these needs, but they should be used in a comprehensive program of special mission tactics. This program will insure the survivability of a valuable national asset in future conflict.

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29. 305 AREFW/DOJ. "Low Altitude Nav Leg." 22 March 1987.

30. 305 AREFW/DOJ. "High Speed, Low Altitude Air Refueling." 23 April 1987.

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APPENDIX

Appendix A - Low Altitude Test Program Documents

- 1. R-3503/Brush Creek, Low Altitude Air Refueling Evaluation**
- 2. Low Altitude Nav Leg**
- 3. High Speed, Low Altitude Air Refueling**
- 4. KC-135 ART Low Altitude Air Refueling Report**

FROM: 305AREFW/DOJ (Maj Day, 2915)

SUBJ: R-5503/Brush Creek, Low Altitude Air Refueling
Evaluation

TO: 305AREFW/CC/DD/ADO/DOT/DON/DOV/
305AREFS/70AREFS/DOXI

10 Mar 87

1. The following information is provided as a result of a test flight to restricted area 5503 on 10 March 1987 and a low altitude air refueling conducted on 11 March 1987. Both flights were to determine the suitability of R-5503 for low altitude air refueling and evaluate the performance of both the KC-135 and boom system at low altitude. On both flights, time in the area was 30 minutes at altitudes of 5000, 4000, and 3000 ft AGL. Airspeeds within the range of 240-310 KIAS were flown. Air refueling was conducted with locally stationed A-10s.

2. The airspace of R-5503 is more than adequate for low altitude air refueling operations. During the reconnaissance flight, five orbits were flown at speeds ranging from 240-320 KIAS and bank angles of 15-30 degrees. Sufficient area remained, even within the confines of Brush Creek (see attach 1). Leg times averaged four to five minutes. Sufficient navigational aids are available (York VOR/ DME, Dayton VOR/DME, Rickenbacker TACAN) and all are useable throughout the entire area. Ingress and egress of the area was accomplished without coordination problems. During both flights we were cleared direct to Grissom from within the area. While in the area, we noted no VFR light aircraft traffic (a safety observer was in the jump seat) or bird activity. Dayton flight test (GCI) has suggested scheduling activity on Monday (less ANG/AFROS activity) and hours times before 2100Z (GCI closes at that time). One problem noted was, the depicted northern boundary of R-5503 does not align with the Flight Test GCI radar map. This may also reflect the impending move of the northern boundary of 5503 to allow more arrival airspace for Port Columbus.

3. Flight Characteristics: At all speeds, controls feel stiff, as if bending rather than moving the controls. Control is positive. The best advantage is power control. During practice separation attempts, acceleration was 50kts/10 sec. The one possible problem with power management was the increase in pitch from the increased effectiveness of the power. MRT practice operations resulted in immediate pitch changes of two to three

Best Available Copy

degrees. On the air refueling test with A-10s we used NRT for separation and the IBO stated separation was greater than when using HRT at high altitudes. I suggest the use of Normal Rated Thrust for all practice separations during low altitude operations. On the first flight we encountered light chop type turbulence. On the air refueling, well defined light turbulence. The difficulties which this caused during contact and air refueling more than validated the requirement to have less than moderate turbulence. Although the autopilot easily damped the turbulence, boom control was difficult. Also, speeds below 250 KIAS exacerbated the control problem. Suggest increasing refueling speed at least 10 KIAS any time turbulence is present. The best speed for A-10s seems to be 280. Bank angles of 15, 20, and 30 degrees were flown and maintained. The following tables AOA's and Mach numbers were noted at the lower speeds (RH +5000ft, DAT 4 deg C):

KIAS	AOA	MACH
220	.4	.36
230	.35	.38
240	.31	.39
250*	.30	.41
260	.28	.43

* Lower limit of boom control

No additional data taken since Mach number and AOA seemed to be well within acceptable limits.

4. Navigation: There are plenty of targets in and around the area for radar and visual positioning. Ground clutter on the APN-59 of our first aircraft at the low altitude tended to make radar scope interpretation difficult. On the second flight, the scope seemed tuned better. Area maintenance was no problem.

5. Receiver evaluation: Maj Bareither flew approximately five minutes at airspeeds from 270-300 KIAS. Although expressing concern about the increase in power effectiveness, he felt receiver (KC-135 R/T) air refueling was feasible. A receiver-type breakaway was attempted. Deceleration was good with more than enough drag in the higher air densities at the lower altitudes.

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6. Boom control: According to Sgt South, the boom was somewhat sluggish below 250 KIAS but became more typical above that speed. At speeds of 300 KIAS and higher the boom flew the same as at higher altitudes. He also felt that the ride in the boom pod was comfortable in the light turbulence.

7. Conclusions/recommendations:

- a) The area is more than adequate for all receivers and low altitude air refueling operations. I recommend all initial low altitude air refueling training be limited to this area. Considering the speeds and bank angles flown, any type receiver can be scheduled in this area.
- b) Aircraft control is safe and breakaways are enhanced by the low altitude performance. Use NRT for all practice separations.
- c) Other than the low altitude and the possible encounter with small aircraft traffic no hazards were noted. This area has existed for years and from my experience as a resident/private pilot of Ohio, this area is well known and avoided.
- d) All three IFs stated they felt comfortable at all altitudes and at 300 KIAS. Power control is sensitive, power should be set as close to that required to maintain air refueling speed and then left alone. Refueling at 3000 ft was somewhat anticlimactic. I recommend KC-135R/T refueling be conducted at 5000 ft with rendezvous/breakaway altitude 4000 ft. This is only 700 ft off the minimum air refueling altitude. Our RTs need the protection of the restricted airspace as well as the GCI radar protection.
- e) This is a safe procedure for an average Tanker Pilot. Careful consideration should be given to Boom Operator selection. Operation in light turbulence may be beyond the skill level of a relatively inexperienced (<300hrs) Boom Operator. Consideration should also be given to the experience/proficiency level of receiver pilots. I recommend average to above average due to power control.
- f) Future A-10 refueling should be conducted at 280 KIAS.
- g) Air refueling airspeeds should be increased 10kts in light turbulence.
- h) Scheduling should attempt to schedule this area on Mondays (to the maximum extent possible) and prior to 2100(Z) due to GCI duty hours and the increase of convection activity during the summer months.

JAMES L. DAY, MAJ, USAF
Chief, Tactics Division

2 Atch
Area map
Altitudes

Best Available Copy

FROM: 305AREFW/DOO

22 March 19

SUBJ: Low Altitude Nav Leg, 17 March 1987

TO: 305AREFW/CC/DO/ADO/DOT/DON/DOV/305AREFS/70AREFS/DOXI

1. The following information was derived from the low level navigation mission flown on the 17 of March, 1987. This mission was flown in IR-618 and IR-620. Aircraft tail number 0356 (KC-135 R/T) was the aircraft flown for this flight.

2. Mission planning route information: IR-618/620 belongs to the 181 TFG, Terre Haute, Indiana. Currently, the route is the subject of a Congressional investigation and may not be usable in the long term (as per telecon with 181 TFG/POC Lt Col Jim Wilson, AV 724-1234). To minimize the impact of our operations, Lt Col Wilson asked that we fly the route at 2,000 ft AGL. This was not a problem since the route IFR altitude consistently provides 2000 ft of terrain clearance. Attached (atch 1) is the current route information for 618 and 620. Since 618/620 is published in FLIP, I will not elaborate on details of the route. The only real problem with planning, is insuring the 1500 ft AGL requirement in relation to the published IFR altitude. Each route has a published IFR altitude or, in its absence, the top of the published block must be flown. These altitudes may not provide the necessary 1500 ft terrain clearance. Also, sufficient route study must be conducted to determine the highest spot elevations along the route. Ground speeds of 300 kts are good for planning, but allow slim acceleration margins on some legs with high winds. IR 618/620 is a good route for training, if we can use it in the future. It has long straight legs and sufficient turns. IR 618 route time is 28 min @ 300kts ground speed.

3. Aircraft performance: Mission was flown in light turbulence (forecast and encountered). At 300kts the aircraft was controllable within normal, acceptable levels. The entire leg was flown with the autopilot on (rudder,elevator,altitude hold on) or off (rudder axis on). The turbulence necessitated the rudder axis on, and produced dutch roll within 10 to 15 seconds. Recommend all flight at low level in turbulence be flown with a minimum of the rudder axis on. CEVG has recommended flying with the elevator axis/altitude hold off to minimize possible long term wear on the autopilot gyros. In any case, both pilot's radio altimeters should be set at 1000ft AGL for unplanned altitude excursions. Power response was excellent. I must

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emphasize, at 300 kts the acceleration margins are limited. When encountering head winds greater than 20kts, to maintain 300kts GROUND SPEED, 320 indicated must be flown. This allows only +30kts for time control (if behind). As a technique, I recommend keeping 10 to 20 seconds ahead of time during the initial portion of any route. Turn performance was nominal.

4. Navigation: Sufficient targets were present along the route for navigation and varied from multiple cultural and natural returns to sparse regions of limited cultural returns (see attach 2). The radar picture was less than desirable with, on 15 mile range, a five mile "altitude" hole in the center and ten miles of fair radar quality to the scope edge. This area is transited (at 300kts) within 2 min. Various combinations of fast time constant (FTC) and instant automatic gain control (IAGC) were used with minimal effect. Close in, lakes exhibited good land/water contrast. Sufficient TACAN stations exist along the route for the safety observer. Recommend the use of INS/DNS as primary means of navigation with tactical use of the APN-59 to practice emission control.

5. Crew coordination: The safety observer, since this was our initial flight, became more active in location and positioning the aircraft. On future flights, the safety observer should become involved only if it appears that the aircraft is exiting the approved corridor. This places a heavy burden on the safety observer. He/she must clear for other aircraft while keeping track of aircraft position within 2-3 nautical miles. Due to this work load, he/she cannot become involved in crew duties (ie. radio calls, coordination, etc.)

6. Passengers: Light turbulence is beyond the bearable limits of most passengers/extracrew members.

7. Conclusions/recommendations: Low altitude navigation is safe (using the existing parameters) but should not be flown by any squadron crew. Apprehension is evident from some crew members and they may not be suited for the task (especially considering recent aircraft accidents).

A) Crews who are selected for low level, tactical certification should be volunteers and highly experienced. Recommend a good mix of A frame and RT crews

B) Current Operations (DON) should become involved in the planning and maintenance of flight planning information for low altitude navigation.

C) Minimum configuration for autopilots should be rudder axis on. Normal configuration should be rudder, aileron, and heading select on. Also suggest speed deviation switches be on.

D) Radio altimeters should be set at 1000ft. 1500ft is not satisfactory, since we are aiming for 1500FT during low level navigation, the MDA light would be on all the time. Crews would become complacent and ignore it.

E) Produce a low level entry/exit checklist to cover items specific to low level as well as normal descent/after takeoff climb checklists.

F) Duties of pilot crew members:

Individual flying aircraft- Should devote 100% of his/her time flying aircraft.

Individual not flying- Checklists, map reading narrative, systems monitor.

Safety Observer- Clear for other aircraft, intervene if flying safety requires

G) As Navs become more experienced, consider flying the routes at 280kts ground speed to allow sufficient speed margins. In the meantime, if 300kts is flown, keep 15 to 20 seconds ahead of time if winds are greater than 20kts.

H) Emphasis must be placed on emission control and the deemphasis of APN-59 use. The primary means of navigation is

DR/INS/DNS. Lesson plans should emphasize "smart" use of APN-59 emissions rather than running with continuous emissions.

I) Only mission essential passengers should be scheduled as passengers on low level flights. They should be limited to extra crew members, Crew Chiefs, and Intel Personnel.

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Chief, Tactics Division

2 Atch
1. Flip 1B
2. Route chart

FROM: 305AREFW/DOJ

SUBJ: High Speed, Low Altitude Air Refueling

TO: 305AREFW/CC/DO/DOT/DON/DOV/DOXI
305AREFS/70AREFS/1 CEVG/STTK

23 Apr 87

1. The following information is provided as a result of two flights to R-5503 in support of Low Altitude Air Refueling (LAAR) with F-4s from the 901 TFG at Wright Patterson AFB, OH. The first flight was conducted on 23 Mar and the second 23 Apr 1987. Both R-5503 and Brush Creek areas were evaluated for usability.

2. Aerodynamic data- The following information was derived at 6000ft and the indicated DATs:

IAS	AOA	MACH	DAT*
273	.30	.465	+16
275	.31	.47	+16
285	.36	.48	+17
300	.34	.52	+19
310	.25	.529	
315	.22	.53	
320	.21	.535	
330	.18	.55	
335	.17	.565	

* uncorrected (gauge DAT)

Fuel flow at 335KIAS was approximately 4000 Lbs/hr/engine (12,000 tti). The receivers felt comfortable at 315 (normal F-4 air refueling speed). Various speeds were tried in the 300-330 range. Boom controllability was excellent with full deflection available. Receiver mentioned that he could feel some turbulent flow from the inboards. For one set of contacts, we "split" the throttles and he claimed that this was more satisfactory. This seems to be a preference for one receiver and is not considered worthy of continuing for all refuelings. However, it may give an otherwise "uncomfortable" receiver some confidence. Receiver also suggested that planning consideration be given to wingmen having to fly long distances awaiting refueling and the resulting low altitude fuel flows.

3. Area information- Flight Test (radar controllers) work load varies during the day. On the first mission, the boom frequency was required due to congestion on the primary Flight Test Frequency (230.4). On the second, there was less congestion and the primary was utilized. To keep up with receiver status 239.65 (Rino Ops) may be utilized to contact the (Wright Patt) F-4 SOF. During the second air refueling, cloud bases varied from 5000 to 8000 (approx). This resulted in multiple turns and climbs/descents to maintain VMC. Pilots need to anticipate the need to maneuver to avoid clouds. Boom operators must notify the receiver if visual contact is lost.

4. Breakaway- Utilization of NRT for breakaway was further validated on both flights. This results in little pitch change and more than sufficient separation.

5. Boom Performance- An on board CEVG boom operator (during the second air refueling) pointed out the more pronounced tendency for the boom to drop on retraction. The reduction in drag due to retraction must be anticipated to prevent contact with the receiver.

6. Boom Operator Experience- During discussions with IBOs and the CEVG IBO, the subject of Boom Operator (BO) experience was reviewed. No specific hours are satisfactory to determine whether a BO should be qualified for LAAR. The BO is the limiting factor for LAAR crews. Aircraft Commanders and Navigators with average experience and capability can be qualified in one flight. BOs may require two or more flights. Selection for training must consist of a subjective as well as objective evaluation. As a minimum the following should be considered:

1. Volunteer for qualification
2. Comfort in the low altitude environment
3. Aggressiveness
4. Airmanship
5. Current duty position (preference for IBOs)
6. Flying hours
7. C-130 experience (especially for slow fighters, A-10s)
8. Unshakability (turbulence can be annoying)

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Of the eight, probably the least important is #6.

7. Recommendations/conclusions-

- a) F-4s be refueled at 315 KIAS for LAAR
 - b) Consideration should be given to splitting the throttles (inboards back, outboards up), especially during operation in turbulence or with a receiver who has been "spooked" by the low altitude environment.
 - c) Planners (DON) anticipate the increased demand on fuel consumption of wingmen at low altitude.
 - d) The boom frequency be used for subsequent flights in R-5503.
 - e) For receiver status, use 239.65 (Rino OPs)
 - f) Pilots must anticipate maneuvering around clouds/weather. Assistance from the other pilot is a must, since the pilots flying the aircraft will be concentrating on basic aircraft control.
 - g) Boom Operators must be prepared for the inevitable encounter with weather and so notify the receiver if visual contact is lost.
 - h) Boom Operators should anticipate the exaggerated reduction in drag on retraction and prevent the boom from dropping into the receiver.
 - i) Training flights need to seriously consider both the subjective as well as objective criteria for training of Boom Operators selected for qualification.

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FROM: 305 AREFW/DOJ

SUBJ: KC-135 ART Low Altitude Air Refueling Report

TO: 305 AREFW/CC/DO

4 May 87

1. The following information is as a result of a Low Altitude Air Refueling (LAAR) flown on 4 May 1987 in R-5503. The mission involved a Silent Warrior MITO departure and radio silent rendezvous and air refueling at a minimum altitude of 6,000 MSL (approx 4500 AGL). Two KC-135 ARTs from Grissom were flown on the mission (ASN 58-0018 and 58-0011). One aircraft was flown by a DOV evaluator pilot and the other a squadron instructor pilot. Safety observers were on both aircraft. Aircraft 58-0018 received an offload of 25,000 lbs. The average fuel weight during air refueling was 86,000 lbs.

2. R-5503 had an undercast deck at approximately 5000 ft. Winds at altitude were 340-360 at 15 kts. Occasional light chop was encountered but was no factor in the air refueling. Flight Test GCI was unable to work the area due to a radar failure. Control of the area and block altitudes had reverted to Indianapolis ARTCC. This may be a problem for subsequent flights because all published altitudes are not available when ARTCC controls the area. An altitude block must be requested and it may require up to ten minutes to receive the new block. No other area difficulties were encountered.

3. Receiver air refueling was attempted by Maj Ransdale (EP) first and the initial attempt was at 12,000 ft MSL. All contacts were flown at 175-285. Maj Ransdale felt the performance was excellent at that speed and was comfortable with over all aircraft control. The next attempt was at 9,000 ft MSL, followed by 8,000 ft and finally 6,000 ft. Maj Ransdale said that control was consistent at all altitudes. He also felt that auto pilot off air refueling was more stable than auto pilot on. No noticeable adjustment period was needed for the increased throttle response.

4. After about thirty minutes in the area we switched roles and became the tanker. Multiple contacts were flown by the other aircraft at 6,000 ft MSL. Our IBO stated he felt the boom performed well with the full operating envelope available. He indicated the boom did not feel sluggish.

5. The absence of turbulence in the area was a prime factor in the success of this first refueling. We took our best crews under the best conditions and proved that it could be done. We should continue with KC-135 ART LAAR on an experimental basis to adequately investigate the limits of operation in low altitude turbulence. Highly experienced crews should be used until we know more about these limitations.

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